

A CONVENIENT MODIFICATION OF TESTS FOR HYDROCHLORIC ACID IN GASTRIC CONTENTS.

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THE modification consists of a simple process of combining three well-known methods in such a manner as to make it possible to estimate both free and combined hydrochloric acid in the smallest possible quantity of gastric contents and within a space of time calculated to make this practical for clinical use. The three methods referred to are those of Töpfer for free hydrochloric acid, of Honigman and v. Noorden for hydrochloric acid deficiency, and the more recent method of Cohnheim and Krieger for the determination of combined hydrochloric acid, which method has not received the clinical attention which it deserves. The desirableness of possessing some more rapid and fairly accurate method for the determination of the combined hydrochloric acid in the clinic must be evident to everyone whose attention has been given to this subject, for the most accurate methods which we possess, namely, those of incineration, require the experience and laboratory surroundings of the trained chemist for their proper operation, and even then their accuracy is a subject for discussion in some cases.

Of these methods, those of Sjoqvist, Leo, Hehner-Seeman, and Martius and Lüttke have survived the test of time, but of them all the last one is probably the only one which can be adapted to practical use by the clinician. Even this method has been subjected to criticism by Rosenheim and requires a certain chemical skill in incinerating to determine the proper moment when the process is completed, a skill which it is not always possible for the physician to acquire.

Of any of the methods proposed for the determination of the combined hydrochloric acid, that with alizarin, as advocated by Töpfer, is probably the most popular. In this method, practical as it is, the end-reaction is often so gradual and indefinite that the results obtained, except for those of great experience, are valueless in most cases. The well-defined play of colors from yellow to red-violet and pure violet, obtained with solutions of acids, disodiumphosphate, and sodium carbonate become ill-defined in fluids containing proteids in any form, as they may be present in the contents of the stomach. A trial with a 1 per cent. neutral solution of egg albumin to which has been added a known quantity of one-tenth normal hydrochloric acid solution (albumin solution 5 c.c., 0.5 HCl solution 2 c.c.) will convince one of this. The quantity of combined hydrochloric acid in such a mixture would correspond to 0.8 c.c. of the normal solution, thus leaving 1.4 c.c. as

free hydrochloric acid. Titrating such a combination with alizarin, the pure violet tint does not appear until the point at which all the free hydrochloric acid has been neutralized has been decidedly exceeded, while the change itself from yellow to violet is most gradual. In gastric contents these inconveniences are markedly increased, due probably to the more complex composition of the same, to the diversity of original color which they possess, or to opacity and cloudiness which result from particles in suspension that cannot be removed by ordinary filtration.

In this connection I would like to call attention to the method elaborated by Cohnheim and Krieger for the determination of the combined hydrochloric acid in gastric contents, for, while not absolutely accurate from a chemical standpoint, it yields results which surpass in exactness any of our possible clinical methods, especially as its shortcomings are known, and any necessary corrections can be made in the results. The method itself is not so well known but that a short description might be in place. Its action depends primarily upon the precipitation of all proteids in solution by phosphotungstic acid. For this purpose Cohnheim and Krieger employed a 4 per cent. solution of calcium-phosphotungstate. Such a solution added in excess to a solution of proteids containing hydrochloric acid in excess will precipitate all the proteids as proteid-phosphotungstate, whereas the hydrochloric acid previously combined with the proteids will enter into solution as neutral calcium chloride. In gastric filtrates which do not contain free hydrochloric acid in excess a certain known quantity of 0.5 normal hydrochloric acid solution should be added and this taken into account in the final calculation. Hence, given the total acidity of the gastric filtrate with phenolphthalein and the total acidity obtained after precipitation with the calcium phosphotungstate solution, we would have a difference which should represent the combined hydrochloric acid.

In a comparison of the results obtained by their method with those obtained by that of Sjoqvist, Cohnheim and Krieger report errors ranging from 5 to 10 degrees. I am convinced that these can be reduced materially by slight modification of method. One source of error lies in the difficulty of securing the whole excess of acid in the filtrate after precipitation of the proteids. For this purpose repeated washing of the residue would be necessary, which in turn would increase the volume of the filtrate to such proportions as to render all color reactions unreliable. Another source of error lies in the fact that in most subacid gastric contents certain proteid products are in solution in excess of the hydrochloric acid present. These products combine with the hydrochloric acid added in excess to secure complete precipitation with the calcium phosphotungstate and help to swell the pre-existing combined hydrochloric acid. In order to eliminate the first source of error it has been my custom to avoid washing off the pre-

cipitated proteids by employing only one-half of the known total filtrate and multiplying the result by 2, the customary procedure in the estimation of the total chlorides by the method of Martius and Lüttke. The second source of error, which is confined to gastric contents containing no free hydrochloric acid, can be corrected by first determining the hydrochloric acid deficiency in the gastric contents according to the idea suggested by Honigman and subtracting this deficiency from the quantity of combined hydrochloric acid found. The details of this second modification I shall describe later.

In a long series of comparative analyses of hyperacid, subacid, and anacid solutions, both natural and artificial, by this method and that of Martius and Lüttke, I have found that the error could be reduced to 4 degrees if the suggested modifications were employed, and that the error was usually upon the side of excess rather than deficiency. In many instances the results were alike. As the method of Martius and Lüttke is not faultless, it was difficult in some instances to decide to which to ascribe the difference in the results obtained; but as an error of 4 degrees cannot vitiate the value of either method from a clinical standpoint, it would hardly be necessary to discuss it further.

In order to make it possible to rapidly estimate the combined and free hydrochloric acid in the same 5 c.c. of gastric contents I have combined and modified these three given methods. The solutions necessary for this are the usual 0.1 normal sodium hydrate solution, 0.1 normal hydrochloric acid solution, and the 4 per cent. neutral solution of calcium phosphotungstate. The latter is easily prepared by dissolving 4 grammes of phosphotungstic acid in 100 cubic centimetres of distilled water by boiling and then neutralizing the boiling solution with an excess of calcium carbonate. The boiling should be continued for a few minutes to drive off the carbon dioxide, after which the solution can be filtered into a vessel graduated at 100 c.c., and whatever fluid has escaped by evaporation can be replaced. These three solutions are stable, and can be kept in burettes ready for use.

The operation itself would be the following: 5 c.c. of filtered gastric contents are measured into a small dry beaker and the free hydrochloric acid estimated with dimethylamidoazobenzol. In doing this it would be wise to follow the advice of Hâri not to carry the titration beyond the deep orange tint. The total acidity is next determined by adding phenolphthalein to the mixture and titrating to the limit of reaction. The results obtained being noted, a quantity of 0.1 normal hydrochloric acid solution, corresponding to the quantity of sodium hydrate solution already employed, is added to obtain the original total acidity of the gastric contents. The total number of cubic centimetres of the mixture being known (gastric contents + 0.5 NaOH + 0.5 HCl), the calcium-phosphotungstate solution is added in sufficient

quantity to bring the whole up to 30 c.c. (15 to 20 c.c. usually are necessary). The mixture is thoroughly agitated and allowed to stand three to four minutes. In order to decolorize the same a small quantity of chemically pure animal charcoal is thoroughly stirred into it and the whole filtered through a dry filter into a dry beaker. The animal charcoal not only retains all the color, but also holds back the phenolphthalein, which substance would otherwise render the following titration uncertain. The filtrate is colorless and very rapidly obtained.

Of this filtrate 15 c.c. are measured into a dry beaker and the total acidity determined with the sodium hydrate solution. The result doubled would give the new total acidity of the whole mixture. As phenolphthalein does not give a clear end-reaction in the presence of calcium-phosphotungstate, Cohenheim and Krieger employed for this titration a 1 per cent. alcoholic solution of rosolic acid. Six drops of this added to the 15 c.c. employed will give a yellow clear fluid which turns to red when the acid is neutralized. The titration should be carried out rapidly and to an end-reaction over a white underlying surface. If any uncertainty as to the end-reaction exists it is safer to add a few drops more of the sodium hydrate solution as any error will be largely in favor of finding the total acidity too low. The difference between this last total acidity and that obtained originally with phenolphthalein will represent the quantity of combined hydrochloric acid in the 5 c.c. of gastric contents employed.

The successive steps in the operation, which requires no more than ten minutes, would be the following:

1. Determine the free HCl with dimethylamidoazobenzol.
2. Determine the total acidity with phenolphthalein.
3. Add 0.5 HCl solution in quantity equal to 0.5 NaOH employed.
4. Add sufficient calcium phosphate to make 30 c.c.
5. Allow to stand three to four minutes, add animal charcoal, and filter.
6. Determine the total acidity with rosolic acid.

EXAMPLE.

Employed gastric contents . . .	5 c.c.	
" 0.5 NaOH . . .	4 "	(free HCl = 20, total acid 80).
" 0.5 HCl . . .	4 "	(total acid 80).
" Na_2WSO_4 . . .	21 "	
Total number c.c. . .	30 c.c.	(total acid) 45
Combined HCl = (80-45) . .	35 "	

In order to secure correct results it is essential that hydrochloric acid should be present in considerable excess, hence the method as given can only be employed where such is the case. In gastric contents which are subacid a slight modification is necessary to secure complete precipitation of the proteids. This can be accomplished by the addition

of an excess of 0.5 normal hydrochloric acid, but in so doing it would be necessary to estimate the hydrochloric acid deficiency according to the idea suggested by Honigman, for any proteid substances in solution not combined with hydrochloric acid would immediately combine with the supplied acid and be added to the real quantity of combined hydrochloric acid originally present. For example, if to a known solution of egg albumin only one-half the quantity of hydrochloric acid necessary to combine with all the albumin present is added, and the operation of titration carried on as given above, the final result will represent the quantity of hydrochloric acid which would combine with the whole of the albumin present. It can readily be seen that the same would take place in subacid gastric contents capable of combining with hydrochloric acid without yielding equivalent acid returns. In order to correct the error the hydrochloric acid deficiency should be subtracted from the quantity of combined hydrochloric acid found in the final calculation.

The modified operation would be the following:

1. Determine the hydrochloric acid deficiency with dimethylamidoazobenzol by adding 0.5 normal hydrochloric acid, and note the quantity employed.

2. Determine the total acidity of this mixture with phenolphthalein and 0.5 normal sodium hydrate. This total acidity minus the quantity of hydrochloric acid added would give the original total acidity of the 5 c.c. of gastric contents employed.

3. Add 0.5 normal hydrochloric acid in excess. Sufficient should be added to make the new total acidity at least 40 degrees higher than the original total.

4. Having noted the total number of cubic centimetres in the mixture, add sufficient calcium phosphotungstate solution to make 30 cubic centimetres and proceed as in the original method. The difference between the total acidity obtained by hydrochloric acid in excess and the final total acidity will represent the quantity of hydrochloric acid combined with all the albumin in the 5 c.c. of gastric contents calculated in degrees. This combined hydrochloric acid minus the hydrochloric acid deficiency will represent the quantity of hydrochloric acid originally combined with proteid in the specimen examined.

EXAMPLE.

Employed subacid gastric contents	5 c.c.
HCl deficiency (dimethylamidoazobenzol)	1 " = 20
Total acidity (phenolphthalein)	3 " = 60
Original total acidity	(60-20) " = 40
Added HCl in excess	3 " = 60
" calcium phosphotungstate	18 "
Total acidity (rosolic acid) of	30 " = 30
Total possible combined HCl	(60-30) " = 30
Actual combined HCl in gastric contents	(30-20) " = 10

In order to secure good results it is necessary that all measurements should be made with great accuracy and that all vessels and pipettes should be perfectly dry. The animal charcoal should be chemically pure and should be tested before using. It is especially important not to carry the titration with dimethylamidoazobenzol beyond the deep orange tint, whereas those with phenolphthalein and rosolic acid should be carried to the full limit. Operating in this way the error can be reduced to 4 degrees, usually as excess of combined hydrochloric acid, and the necessary allowance can be made. As 4 degrees represent a quantity of hydrochloric acid equal to 0.146 per 1000, it is evident that the method is sufficiently exact for most purposes, and requires but little more time than the determination of the free hydrochloric acid and total acidity as usually practised in offices and clinics.

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TWO CASES OF RELATIVE AORTIC INSUFFICIENCY.

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Relative aortic insufficiency, by which is meant an incompetency of the semilunar valves without an organic lesion of the valves, is so rare that no excuse is needed for recording two such cases which occurred in the Medical Department of the Royal Victoria Hospital.

Edwards,¹ in 1895, stated that aortic is the rarest of all relative insufficiencies, and that the combined literature of England, France, and Germany did not record more than about twenty-five cases, while some of these were reported twice, though dearth of detail precluded their detection. In the modern text-books there can be found but scant if any reference to the condition.

CASE I.—J. H., aged fifty-nine years, paper cutter, was admitted December 15, 1902. About three weeks before admission he com-

¹ THE AMERICAN JOURNAL OF THE MEDICAL SCIENCES, vol. cx. p. 438.